International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Allelopathic Impact of Parthenium Hysterophorous L. on Sorghum Bicolor and Zea Mays

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Abstract

In this writing studies on weed, allelopathy and allelochemicals have been made and the present study suggests that *Parthenium hysterophorous* L. affects the agroecosystem and needs careful attention. Weeds continuously affects the growth of crops plants present in its vicinity. These unwanted plants needs carefull attention to have a greater yield of the crop in which it grows. These unwanted plants called as weeds releases harmful biochemicals known as allelochemicals in their vicinity that affects the growth and reproduction capacity of the growing crop that area. *Parthenium hysterophorous* L. being a declared invasive weed is threatening the biodiversity world wide. However, the extracts can be used as a viable weed management technique, but further studies are needed to explore the full potential of *Parthenium* as a bioherbicide.

Introduction

The potentiality of some plant species to affect surrounding plants has been well recorded since ancient time. Weed is a plant that grows on a place where it is not required, the same plant at other places where it is cultivated is considered as a commercial crop.

- "The obnoxious plants are known as weed" (W.W. Robbins et al.1942)
- 'Those plants with harmful or objectionable habits or characteristics which grow where they are not wanted, usually in places where it is desired that something else should grow" (W.C. Muenscher, 1946).
- "Weeds persistently contend with crops causing a substantial loss in their yield" (Mushtaq & Siddiqui, 2018).

Some commercial crops that suffer reductions in their harvest due to weeds are as follows: Wheat 23%, potatoes 30%, cotton 36%, rice 37%, soybean 37%, and maize 40% (Oerke, 2006). Most of the plants either weed or commercial crop plants possesses allelopathic potential i.e. different parts leaves, stem, roots, rhizomes, seeds, flowers and even pollen of plants are capable of producing biochemical compounds which are harmful for the other plants in their vicinity.This biochemical interaction between crop & weed, between weed & weed and also between crop & crop is termed as allelopathy. These biochemicals are termed as allelochemicals.

Increasing environmental & health hazards have increased interest in biological control strategies. Allelochemicals can provide a good alternative for chemical herbicide. Allelochemicals are plant secondary metabolites which are presented in biological & toxicological screens so as to identify their allelopathic potential as a bioherbicide. Using different techniques such as Nuclear Magnetic Resonace

(NMR) spectroscopy, High Performance Liquid Chromatography (HPLC) which are based on spectral characteristics of the substances has made a way to isolate, identify & quantify the allelopathic compounds produced by the plants.

Once these substances are identified & characterized they can be used either as natural herbicides or as models for developing new and environment friendly herbicides.

Parthenium hysterophorous L. being a declared invasive weed is threatening the biodiversity world wide (Amin, Rashid & Khan 2007). It possesses allelopathic potential and drastically retards the growth of many species. Tefera (2002) concluded that with the increasing concentration of Parthenium extracts, seed germination and growth of Ergrostis tef decreased significantly. Parthenium has spread rapidly in India over last 20 years and is now a serious weed of waseland 9 and grazing lands, especially in rainfed areas (Javaid & Anjum, 2006). Presently Parthenium can be found along the roadsides and even in agricultural croplands. Other species could hardly establish themselves in a field infested with Parthenium due to the antagonistic effect of toxins produced by different parts of the weed. Parthenium is not only damaging the crop plants, but also possesses a serious human and animal health risk due to these dangerous toxins. It also reduces the quality of dairy products if dairy cows are feed to the weed. To know about Parthenium hysterophorous effects, habitat and its biology have immance significance in different ways. Present review explores the possibility through knowing habitat, distribution, biology and chemical properties of this noxious weed and its allelopathic impact on Sorghum and Zea mays. Therefore a detailed study of this weed will lead towards a better management approach and its possible use as a bioherbicide.

CONCEPT & HISTORY OF ALLELOPATHY:

- The earliest record of weed and crop allelopathy was given by Theophrastus, ‘the father of botany’, who in 300 B.C. wrote in his botanical work about how chickpea ‘exhausted’ the soil and wrecked weeds (Khalid, Ahmad, & Shad, 2002).
- “Allelopathy” ,term was coined by Molisch (1937) from two greeck words: ‘allelon’(meaning- ‘of each other’) and ‘pathos’(meaning- ‘to suffer’).
- Historical background of allelopathy could be partitioned into three phases (Singh, Batish, & Kohli, 2001)
- DeCandole Phase (period of late 18 th & early 19 th century, between 1785-1845)
- Pre-Molisch Phase (period of early 20 th century, from 1900-1920)
- Post-molisch Phase (period 1937 onwards that showed progress since 19

HOW ALLELOPATHIC COMPOUNDS ARE RELEASED INTO THE ENVIRONMENT?

Almost all the parts of the plant that possesses allelopathic potential releases allelochemicals in the environment through various pathways. The following are known pathways:

- Exudation and deposition on the leaf surface with subsequent washing off by rainfall;
- Exudation of volatile compounds from living green parts of the plant;
- Decay of plant residues (e.g., litterfall or dead roots);
- Root exudation.

Different types of abiotic and biotic stress can also alter the production and release of allelochemicals during the vital cycle of plants. Drought, irradiation, temperature, nutrient limitation, competitors, disease and damage from insects have been 12 pointed out as factors that can cause an increased release of allelochemicals from allelopathic plants

ABOUT THE SELECTED WEED PLANT: Parthenium hysterophorous L.

Identification & Classification:

Kingdom – Plantae
Division – Phanerogams
Class – Dicotyledones
Subclass – Gamopetalae
Series – Inferae
Order – Asterales
Family – Asteraceae
Genus – Parthenium
Species – hysterophorous

DESCRIPTION:

Parthenium hysterophorous is an invasive weed of family Asteraceae. This erect (upright), short lived (annual) herbaceous plant is known for its flourish growth and its abundance notably in hot climates. The plant forms a rosette habitat during the early stages of of life and at maturity, but occasionally can reach upto 2m or even more in height. Parthenium (Parthenium hsterophorous L.) is known with different names in different countries such as carrot grass, star weed, congress grass, wild feverfew, ragweed, bitter weed, white top, and the "Scourge of India"

Numerous small flower- heads generally known as capitulum are organized in clusters at the top of the branches (in terminal panicles). Five small 'seeds' generally known as achenes are produced in each flower- head. Parthenium hysterophorous retain an extraordinary capability to spread grow and established well in wide range of environmental conditions (Monika, 2014). Its seeds can be dispersed through various methods such as water current, animals, movement of vehicles, machinery, livestock and the grains or seeds 14 of crops.

Figure: *Parthenium hysterophorus* (L.) plant and its Parts:(1) whole plant at maturity (2) Stem of plant (3) rosette habitat of young plant (4) leaves (5)a flowering twig (6) plant root (7)seeds (8) enclosure of seed respectively.

DISTRIBUTION:

- Parthenium is native to the area surrounding the Gulf of Mexico, Central America, southern North America, West Indies, and central South America.
- The weed has now invaded more than 20 countries around the globe, including five continents and numerous islands.
- Parthenium probably entered India before 1910 (through contaminated cereal grain which were imported from USA under the US PL 480 scheme, also known as "Food for Peace") but went unrecorded until 1956. Since 1956, the weed has spread like wildfire throughout India.
- Earliest record of this species goes back to 1814 by Roxburgh, the father of Indian Botany, in his book- Hortus Bengalensis.
- Parthenium is one of the major biotic limiting factor to the production of different crops and grazing land.

  To collect accurate information on the distribution spread and impact of 15 Parthenium, field survey was conducted in central & southern parts in Ethiopia (Kassahun & Mersie, 2006-2007)

  The survey results indicated that it has wider spread, infesting most of the surveyed areas. The infestation levels of Parthenium varied from low (in 60% of the Infested fields), moderate or high (in 5% of Infested fields), and to very high (in 35% of Infested fields).
- In India, this weed has serious problem in approximate all states like Karnataka, Andhra Pradesh, Haryana, Bihar, Madhya Pradesh and Uttar Pradesh.

STATUS OF PARTHENIUM HYSTEROPHOROUS IN DIFFERENT STATES OF INDIA

NAME OF STATES	OVER ALL SPREAD AND INFESTATION LEVEL
Andaman and Nicobar Island	Low

Kerala	Low
Andhra Pradesh	High
Madhya Pradesh	High
Arunanchal Pradesh	Low
Maharashtra	High
Assam	Medium
Manipur	Low
Bihar	High
Meghalaya	Low
Chattishgarh	Medium
Mizoram	Low
Chandigarh	Medium
Nagaland	Low
Pondichery	Medium
Gujarat	Low
Punjab	High
Haryana	High
Rajasthan	Medium
Himachal Pradesh	Medium
Sikkim	Low
Jammu and Kashmir	Medium
Tamil Nadu	High
Jharkhand	Medium
Uttar Pradesh	High
Karnataka	High
Uttarakhand	Medium
Orissa	Medium
Goa	Low
Delhi	High

ALLELOPATHIC POTENTIAL OF PARTHENIUM HYSTEROPHOROUS L. –

This noxious weed suppress the development of nearbyplants by allelopathy. Leachate and extract of leaves and inflorescence prevent the germination and growth of associated economically important crops. Kumari et al. (2014) observed that physiological and biochemical parameters remarkably reduced when aquous extract of Parthenium were directly sprayed on the crop plants. Parthenium has strong allelopathic effects on other plants even it can cause 40-80% yield loss in agricultural crops.

TABLE: CHEMICAL CONSTITUTION OF PARTHENIUM

CHEMICAL CLASSES	MAJOR CONSTITUENTS	PLANT PARTS
Sesquiterpene lactones	Parthenin, Caffeic acid, P-Coumeric Acid	Stem, Leaves, and Pollen

Phenolic Acids	Ferulic acid, vanicillic acid, anicic acid, fumaric acid	Roots and leaves
Minor sesquiterpenes	Ambrosonalides, 2B-hydroxycoronopilin, 1,3-hydroxyparthenin	flowers
Sesquiterpene lactones	coronopilin,	Stem, Leaves and trichome
Sesquiterpene lactones	Pseudoguananolides	Stem and leaves
Sesquiterpene lactones	Hystrin	Stem
Secopeudoguananolides	Charminarone	All plant parts
Flavonoids	Aglycone	Aerial parts
Pseudoguananolides	Flavanols Hysterones A to D	Flower
Sesquiterpene Lactones	Acetylated pseudoguananolides	Flower

ABOUT THE SELECTED COMMERCIAL CROPS:
(*Sorghum bicolor* L. and *Zea mays* L.)

IDENTIFICATION & CLASSIFICATION

Kingdom- Plantae
Division- Phanerogams
Class- Monocotyledones
Series-Glumaceae
Family- Poaceae
Genus- *Sorghum*
Species- *bicolor*

Kingdom- Plantae
Division- Phanerogams
Class- Monocotyledones
Series- Glumaceae
Family- Poaceae
Genus- Zea
Species- *mays*

Sorghum bicolor, commonly known as Sorghum and also known as great millet, durra, jowari/ jowar, or milo, is a grass species cultivated for its grain, which is used for food for humans, animal feed, and and ethanol production. Among cereals it occupies fifth position in acreage and production in the world and it is grown on 47.8 million ha.

Zea mays is one of the most important crops for human societies throughout much of the world. Commonly known as maize, corn or Indian corn. Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice

METHODOLOGY:

The general method followed to study the allelopathic effect of a species in different species is formalized in this section on the basis of information gathered with the help of literature cited from different research papers.

MATERIAL & METHOD:

- To make the aqueous extracts of different concentrations of leaves, stem, and roots are separated from the collected weed plant i.e. of Parthenium hysterophorous.
- These plant parts are weighed and dried in shade and then powdered & stored to polythene bags till further use. The powder is soaked in pure water.
- Then the residue is discarded and the aqueous extract is stored in refrigerator for further use.
- For each part aqueous extract of different concentration is prepared.
- The extract obtained is considered as stock solution & as a series of solution with different strength (2,4,6,8 and 10%) are prepared by dilution.
- Uniform and surface sterilized seeds of Sorghum bicolor and Zea mays are evenly placed in separate disposable Petri dishes with two layers of filter paper and moistened witheach extract. For control distilled water is used.
- The treatments are arranged in completely randomized design (CRD) with three replicates under laboratory conditions (Room temperature 25˚C at mid- day and diffused light during day) for 15 days.
- Germination of seeds is evaluated ater every 2 days.
- On 15 th day, physiological observation of radical and hypocotyls and length of both organs are measured.
- All results are statistically analyzed through LSD. The data are subjected to analysis of variance (ANOVA) followed by Duncan's Multiple range Test (DMRT) as per Duncan (1955) and @ sample t-test, wherever applicable.

DISCUSSION AND CONCLUSION:

It has been reported that Parthenium exhibit allelopathic effects thus inhibits the germination and growth of neighbouring plants by releasing various allelochemicals such as water soluble phenolic and sesquiterpene lactones including parthenin and coronopolin (Jaris et al., 1985; Riaz. T and Javaid A, 2009).

The present study show that with the increase in the concentration of aqueous extracts of the weed, there is negative effect on the germination and seedling growth of the crops. In Sorghum seedlings maxium reduction in root length and shoot length is caused by Parthenium leaf leachate. Reduction in fresh weight, vigour index is caused by due to Parthenium leaf leachate. It is evident from the foregoing account that the treatment of leaf leachates of Parthenium exerts a marked influence on different facets of metabolism of germating Sorghum seeds. All these metabolic disturbances are ultimately responsible for the unsatisfactory seed germination and on overall decline in seedling vigour and growth.

Allelopathic effects of leaf and stem extract and dry biomass of parthenium hysterophorous at different concentration on germination and seedling growth and population density of Zea mays shows reduction with the increase in concentration. Phytochemicals are found in aqueous extracts of Parthenium in the form of ex factor residue or growing weed can affect the germination, growth and productivity of Zea mays. So there is an urgent need of integrated Parthenium management strategy to stop further spread of this invasive alien species.

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